Berøringsløs optisk måling af gassammensætning ved UV og IR spektroskopi

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Publisher's PDF, also known as Version of record

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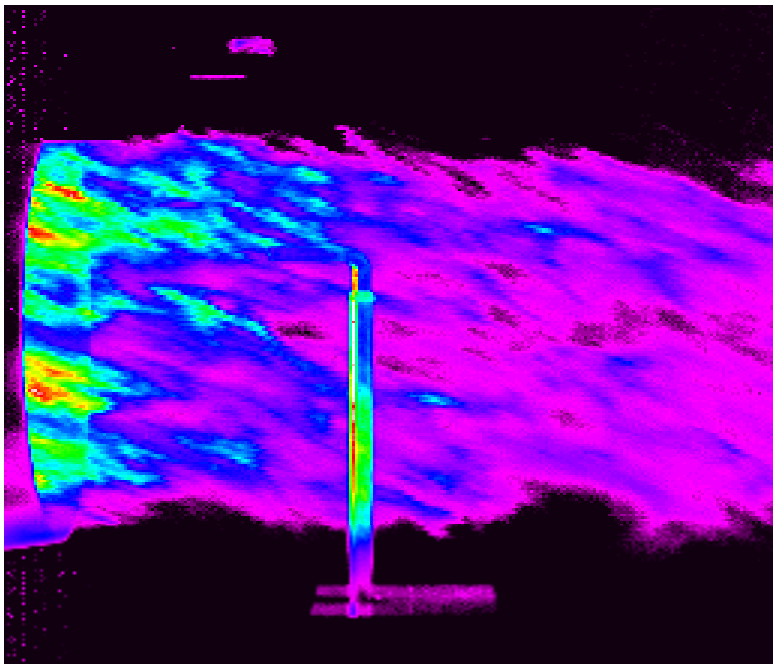
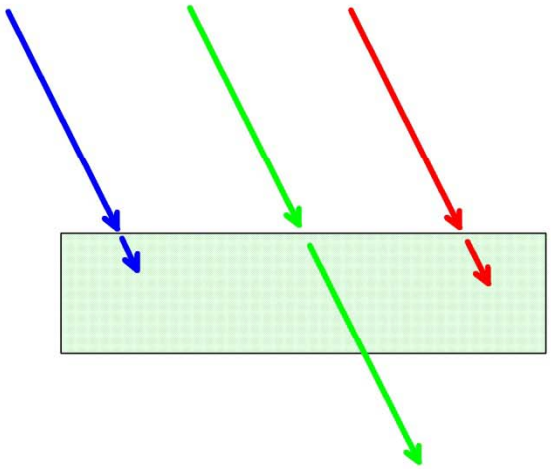
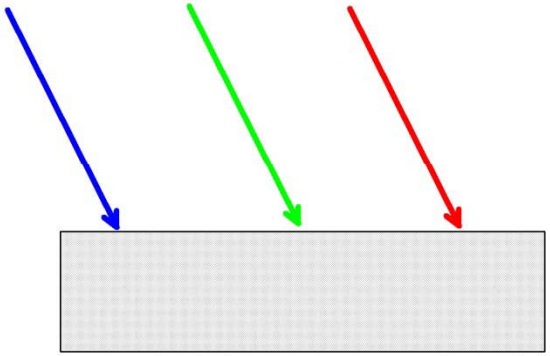
OPTICAL METHODS

- Gas temperature and composition
- Hot gas flow with dust
- Fast respons time
- Large range
- Fiber optics
- 1 - ? process points
- Non-intrusive



ABSORPTION



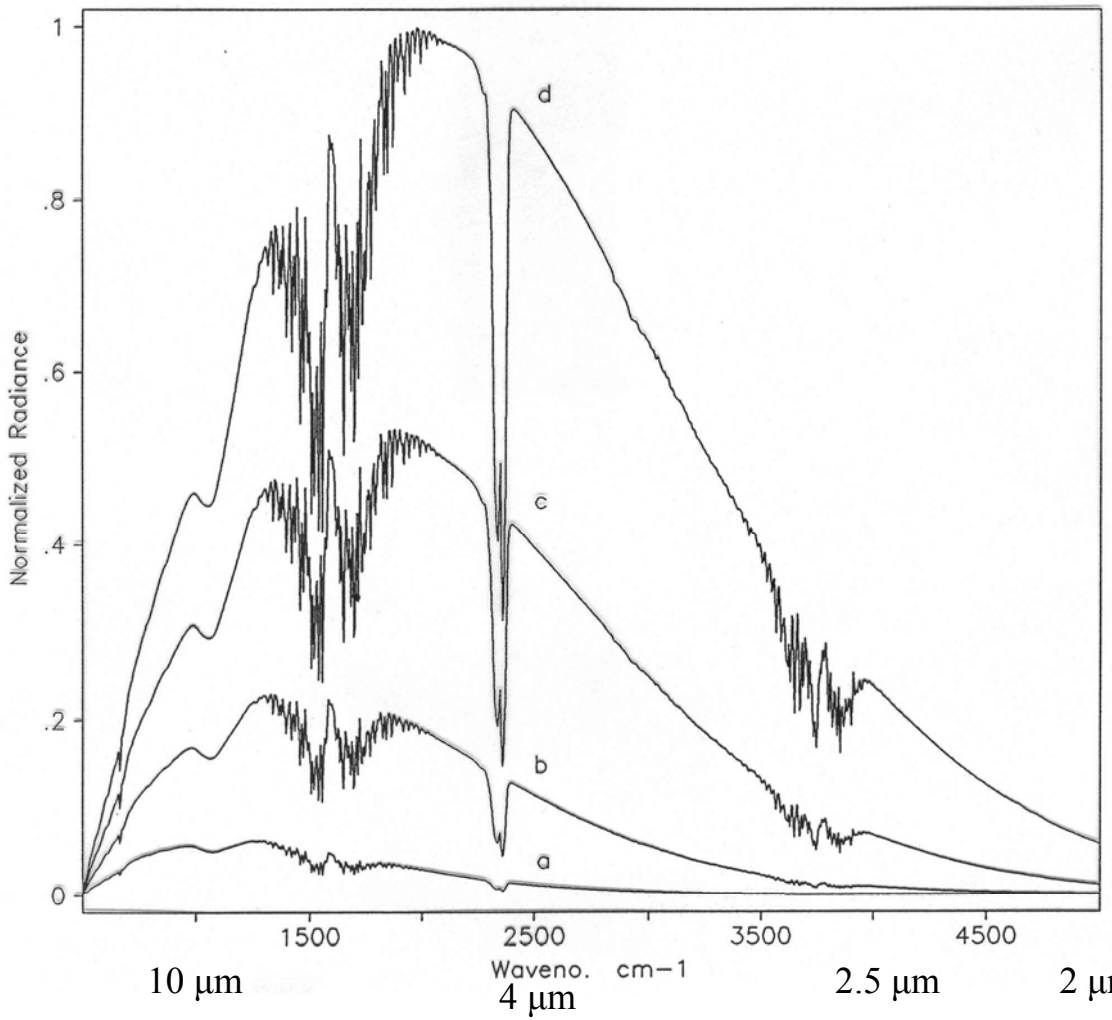


Beer's Lov:

$$I = I_0 e^{-abc}$$

Blackbody-kurver

MÅLT (FTIR)

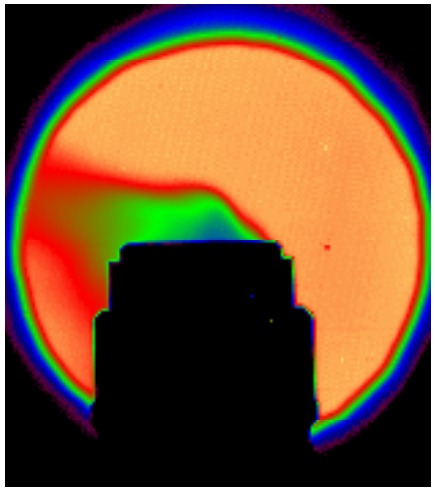


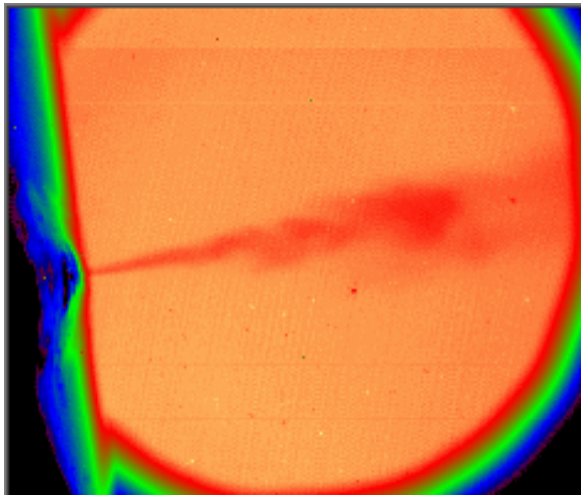
Measurement Techniques

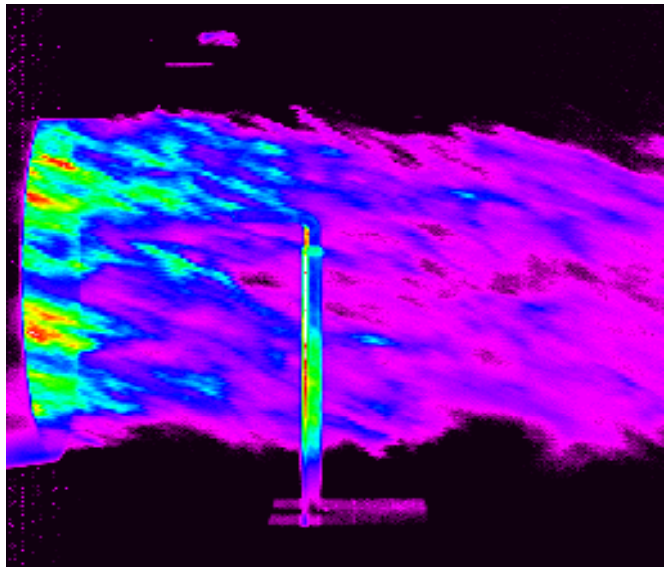
FULL SCALE

- CCD / IR pictures (e.g. high speed IR-camera)
- FTIR emission spectroscopy (2-6 µm)
  (CO, CO_2, H_2O, C_xH_y, T_{gas}, T_{par}, flux)
- UV transmittance spectroscopy (210-350 nm)
  (NO, O_2, SO_2,…)

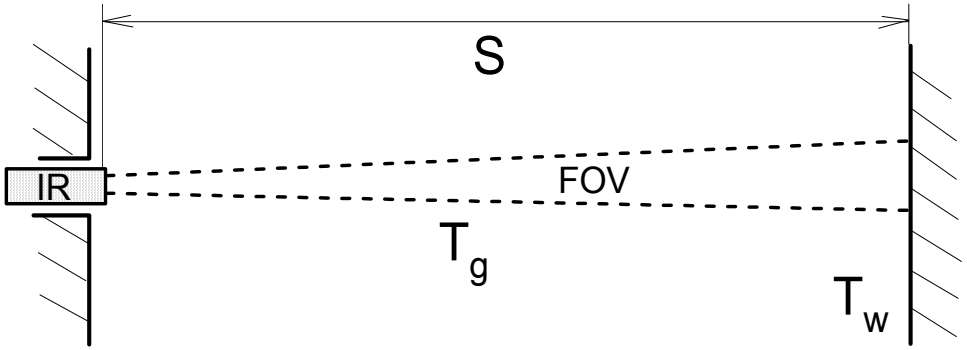
CCD and IR pictures

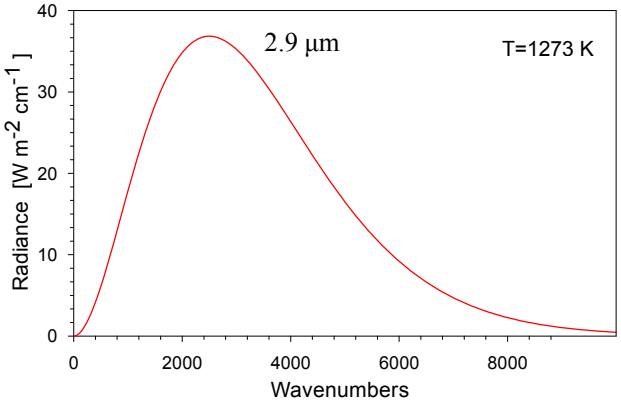






Theory – Principles



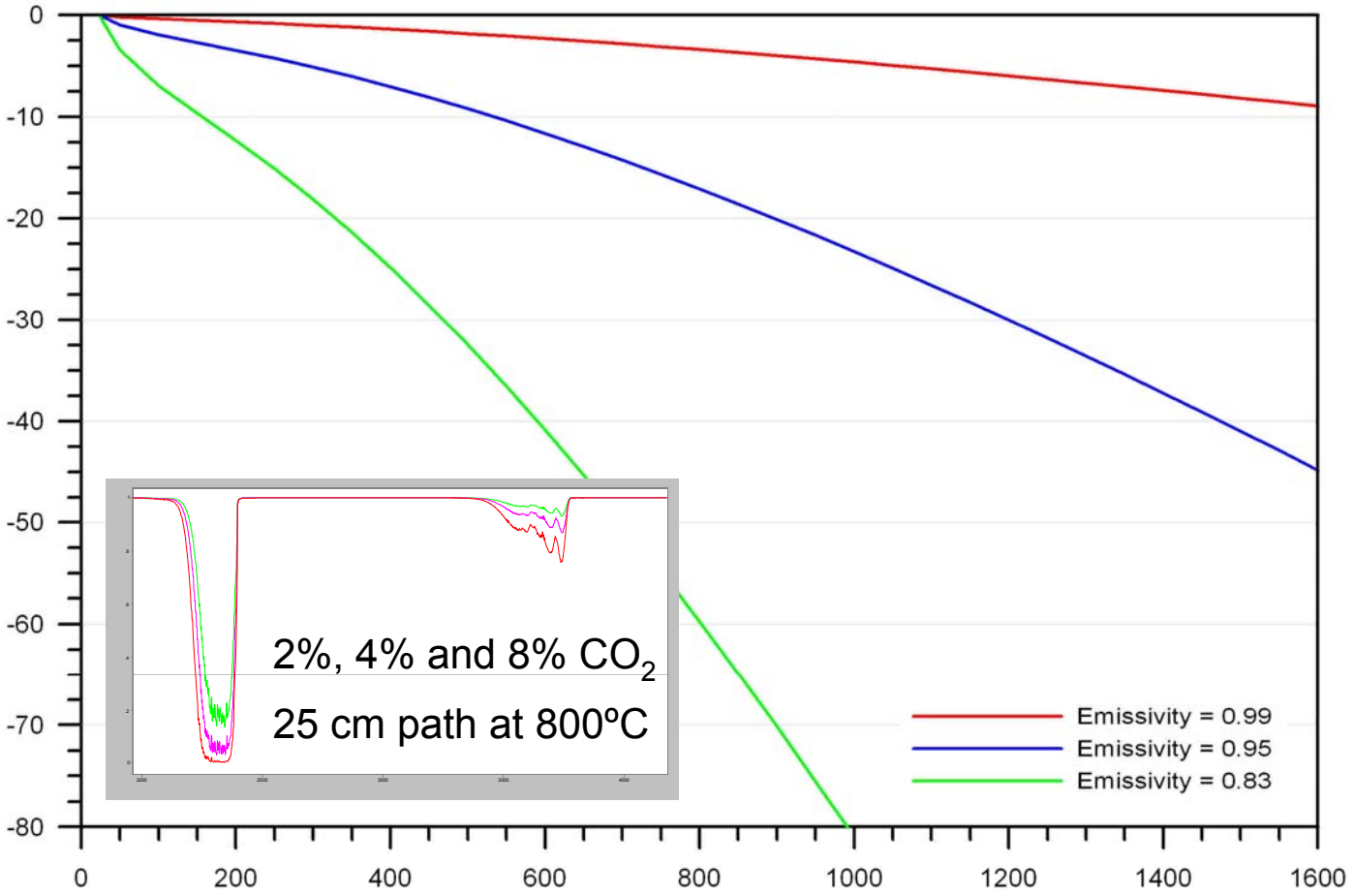


$$(1) \quad L_m(\lambda) = \varepsilon(\lambda, T_{g,c_i})\, L(\lambda, T_g) \;+\; \tau(\lambda, T_{g,c_i})\, L(\lambda, T_w)$$

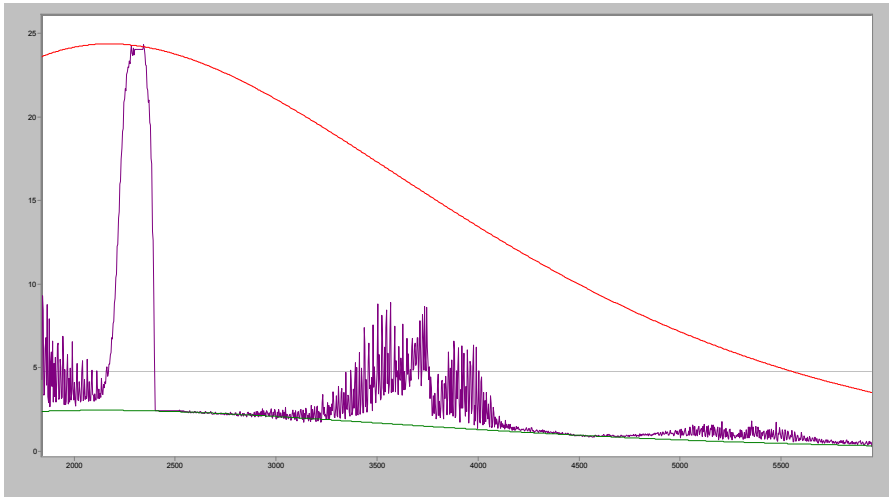
$$(2a) \quad \varepsilon(\lambda, T_{g,c_i}) = \alpha(\lambda, T_{g,c_i}), \qquad (2b) \quad \tilde{\nu} = \frac{1}{\lambda}$$

$$(3) \quad \alpha(\lambda, T_g) = \frac{L_m(\lambda) - L(\lambda, T_w)}{L(\lambda, T_g) - L(\lambda, T_w)}$$

Gas temperature

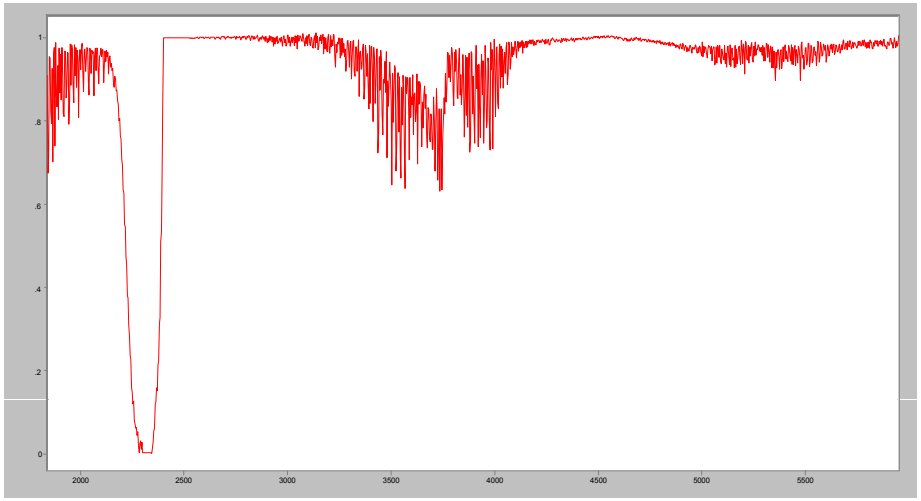


IR gas analysis

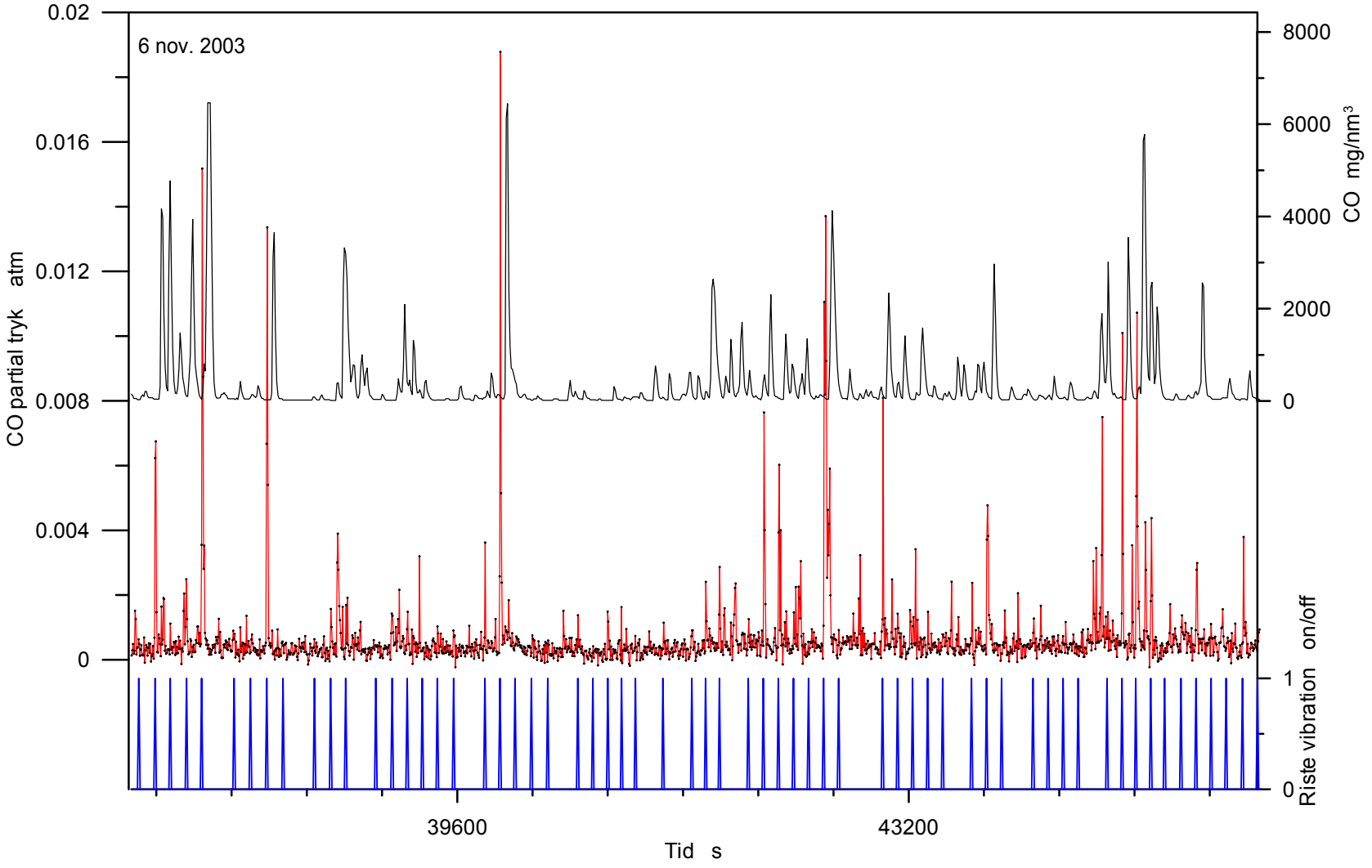


Emission spectrum:
GB: 816.9ºC, ε=0.106
Blackbody curve at 836.0ºC

Transmittance spectrum
CO_2, H_2O, CO, C_xH_y, …

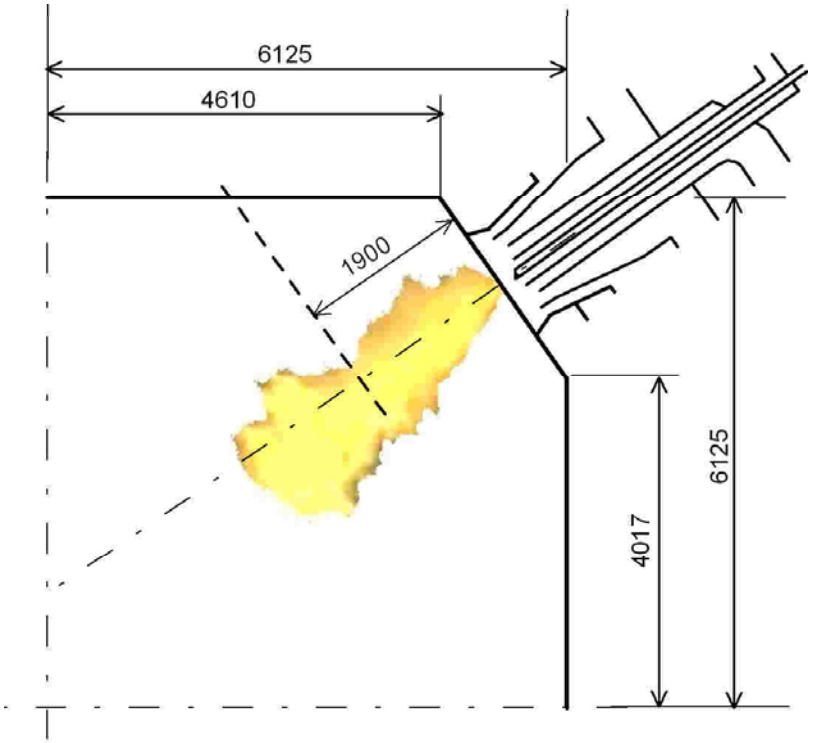


CO Concentration



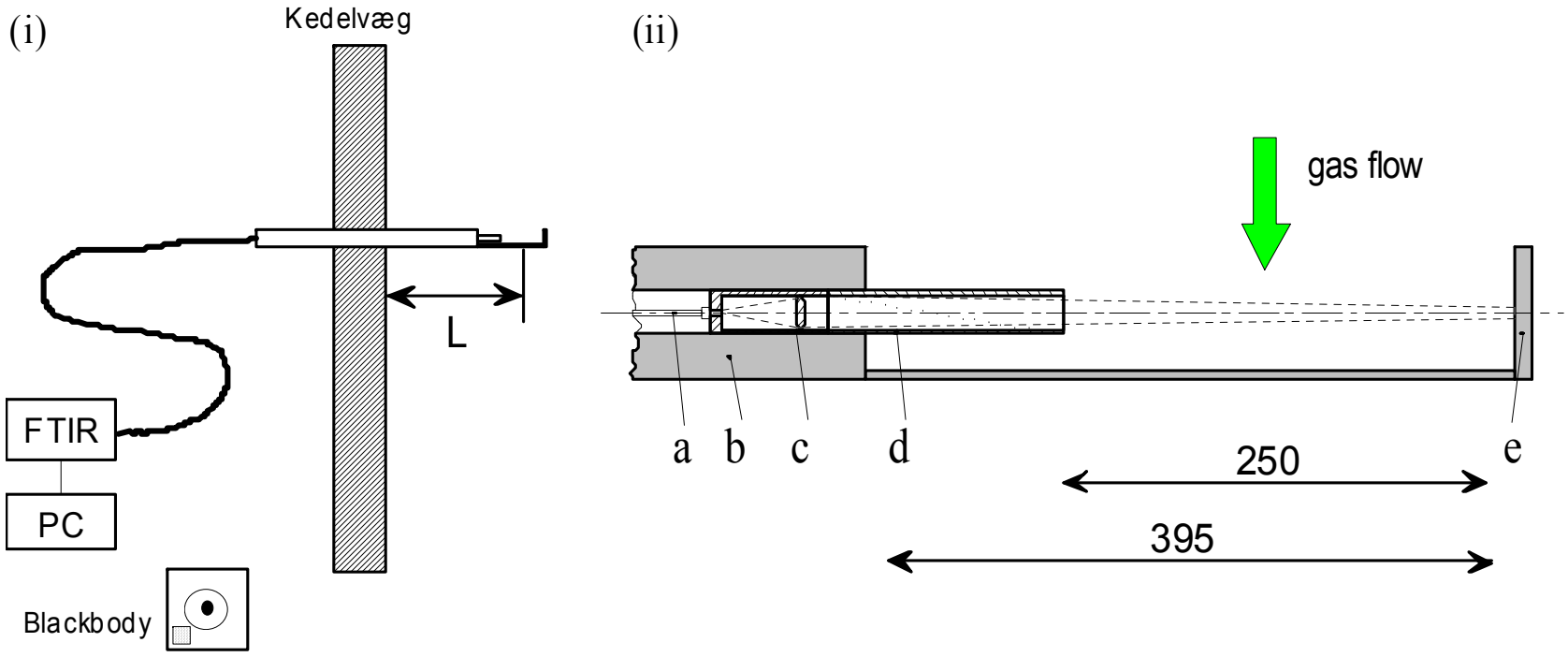
FTIR flame measurements

AVV2 April 2006

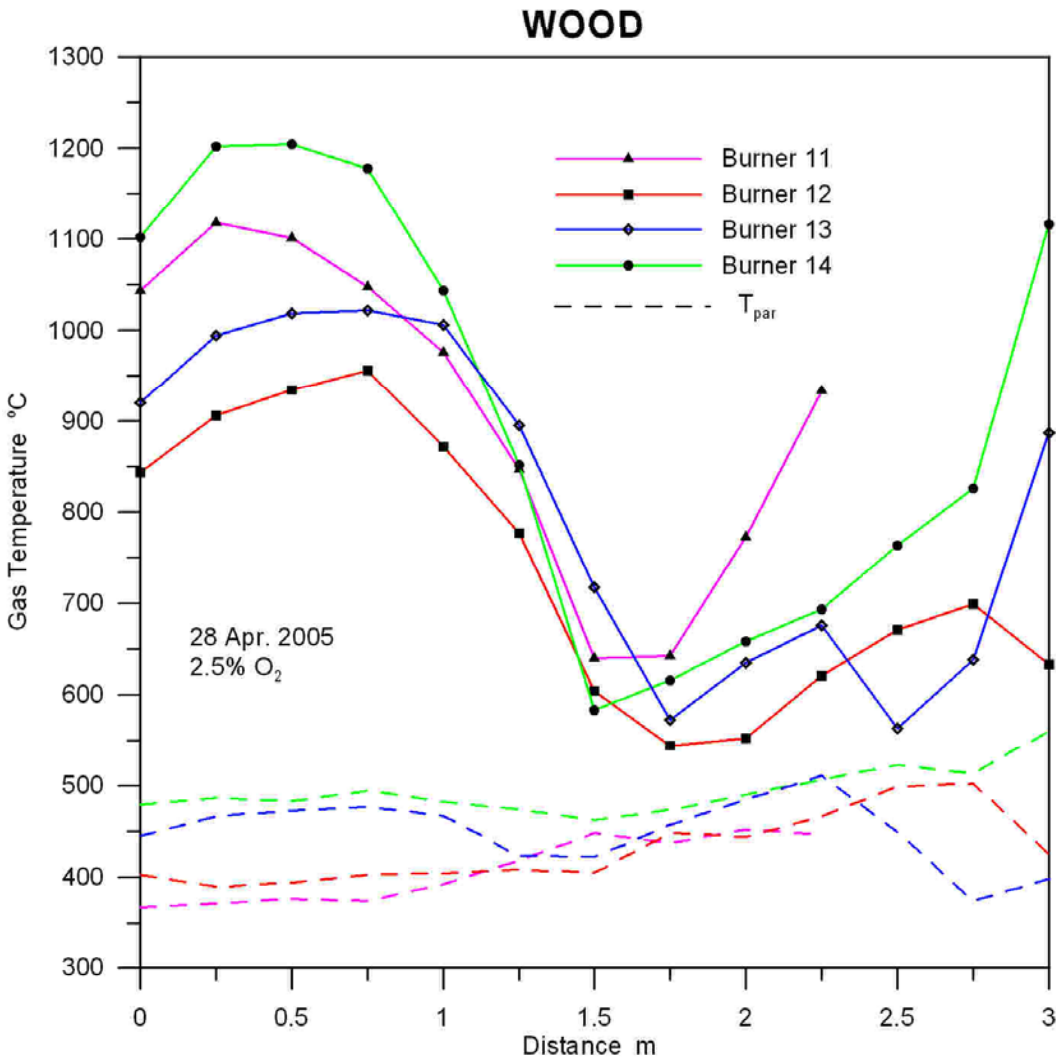


Wood flame

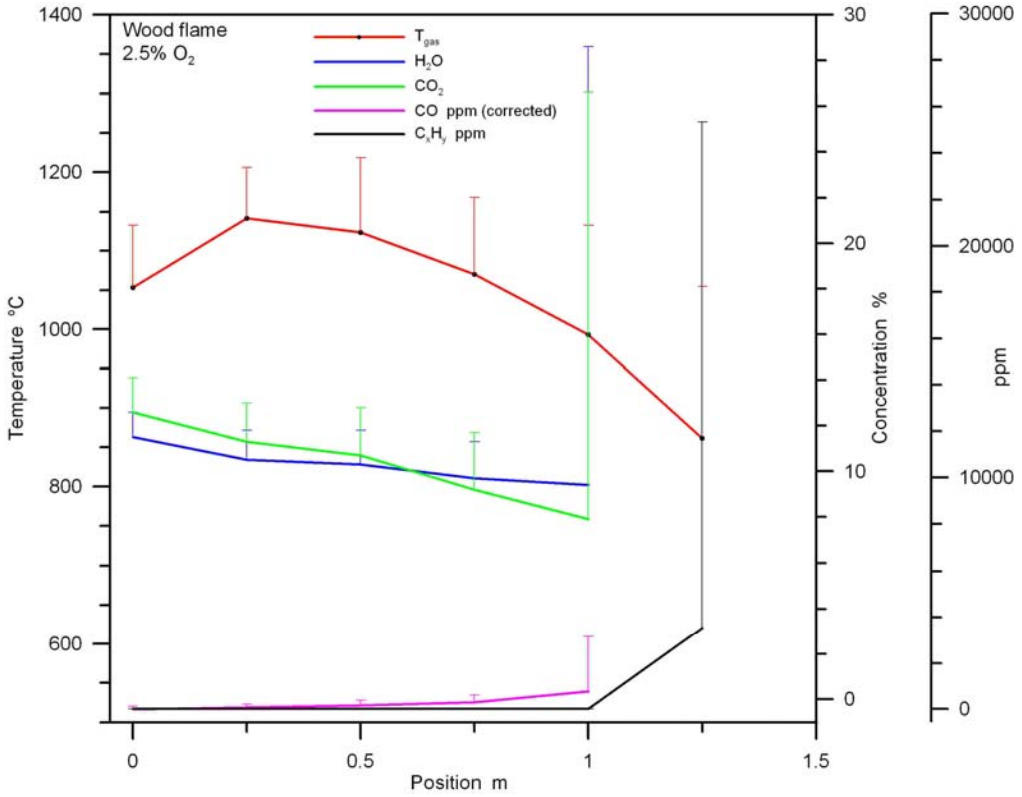
FTIR spectroscopy

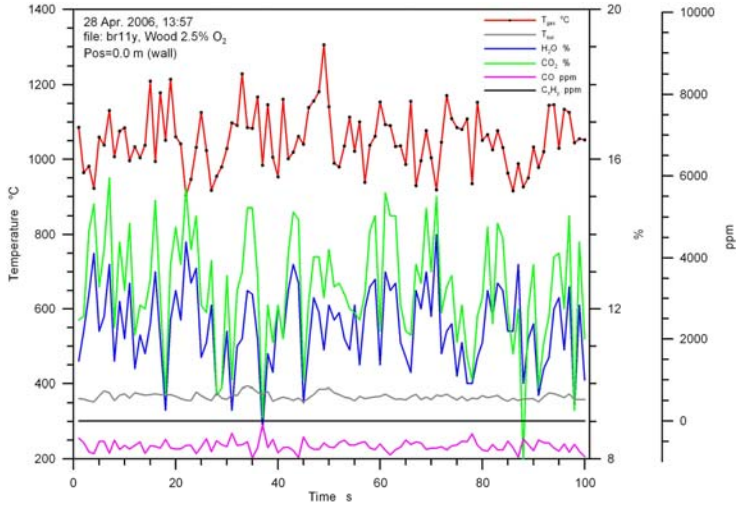


Wood flame temperature

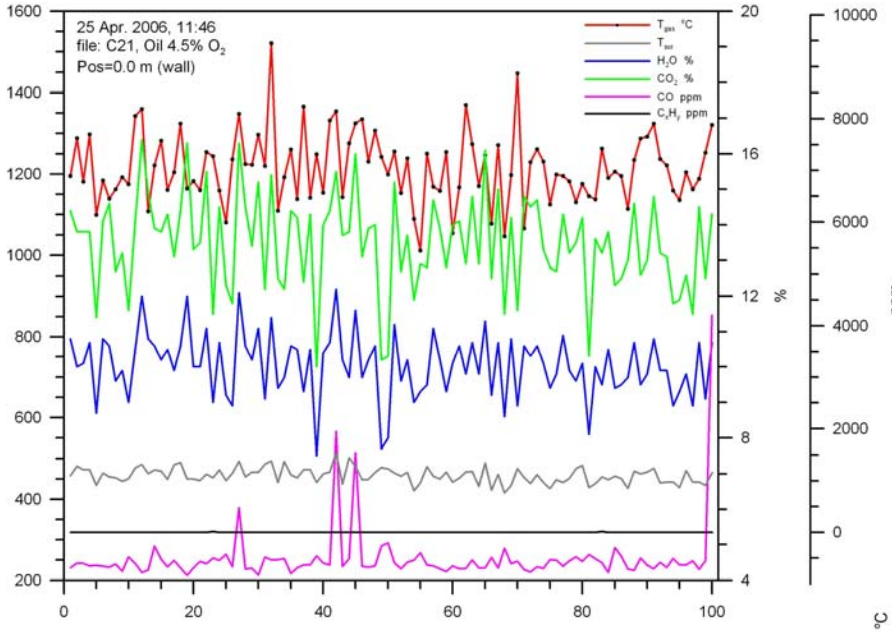


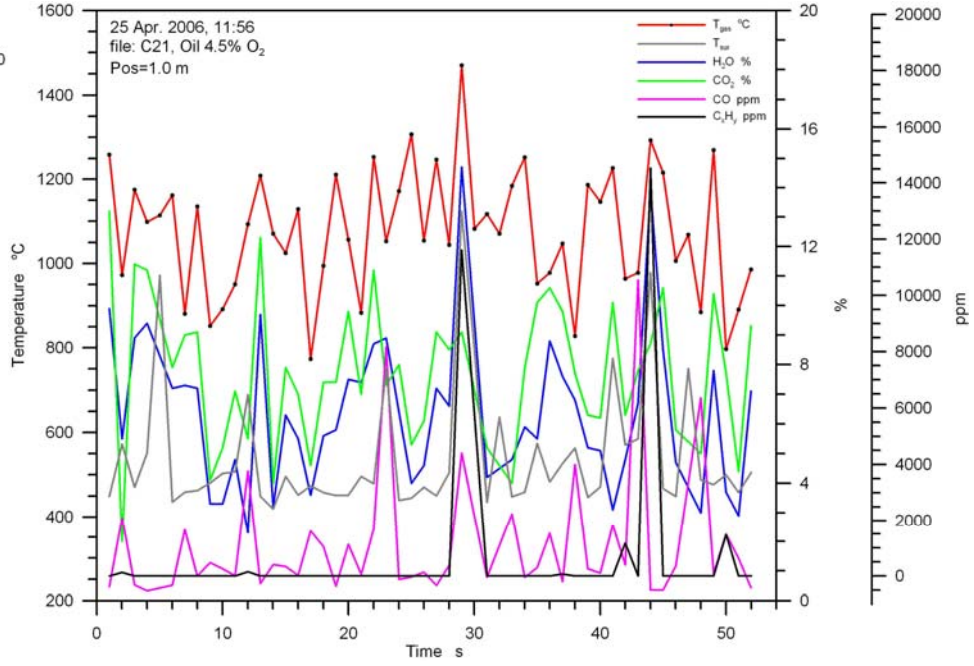
Wood flame gas conc.



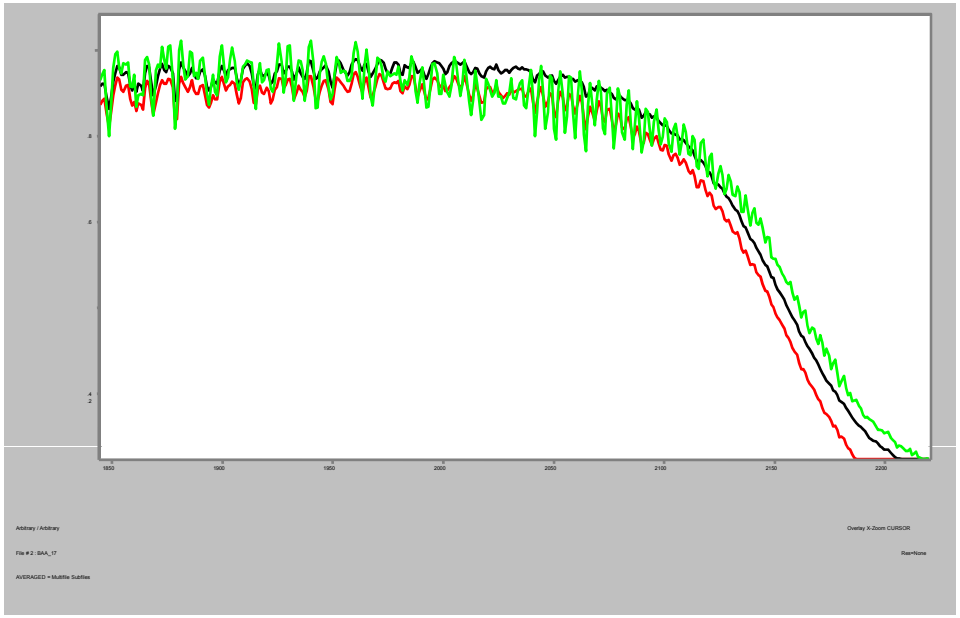


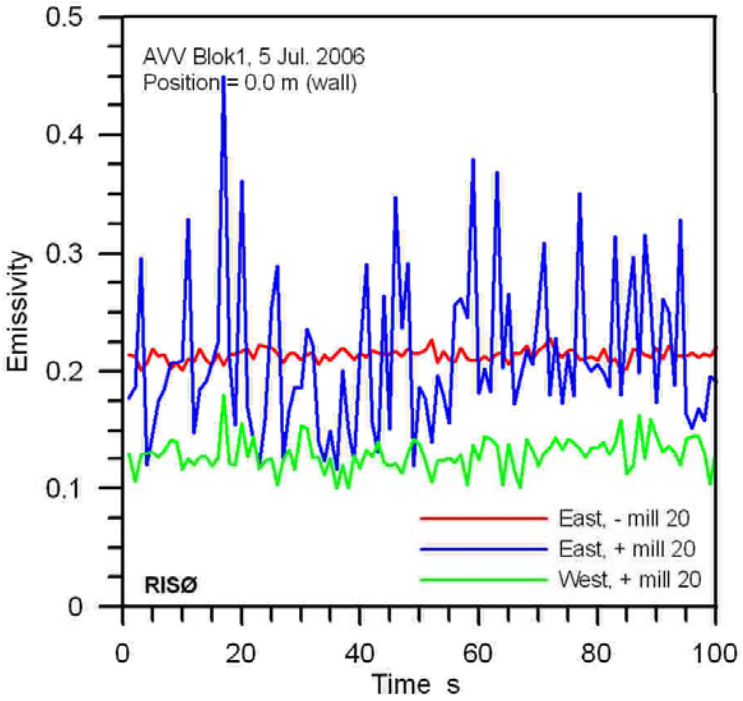
Oil flame


25 Apr. 2006, 11:46
file: C21, Oil 4.5% O2
Pos=0.0 m (wall)
Tgas °C
Tsur
H2O %
CO2 %
CO ppm
CxHy ppm
%
ppm


25 Apr. 2006, 11:56
file: C21, Oil 4.5% O2
Pos=1.0 m
Tgas °C
Tsur
H2O %
CO2 %
CO ppm
CxHy ppm
Temperature °C
%
ppm
Time s

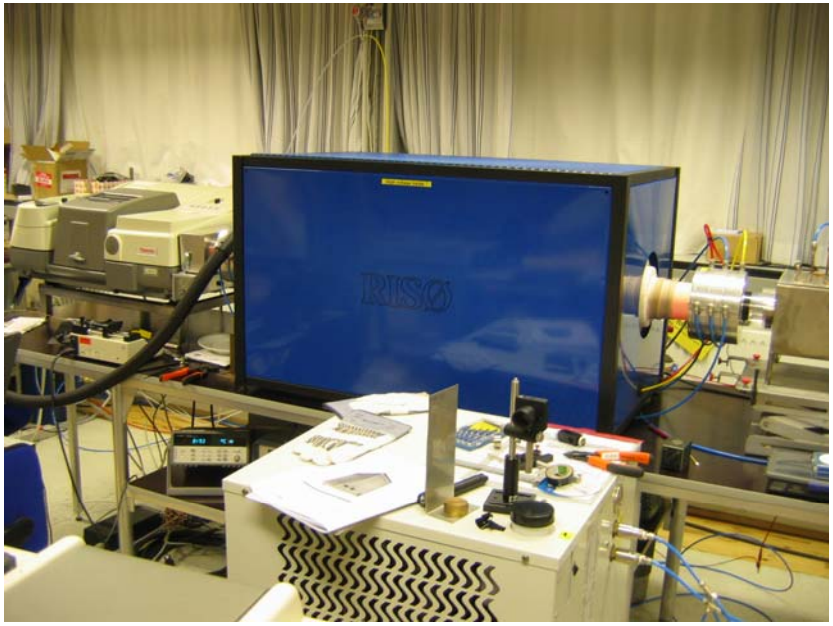
Coal flame

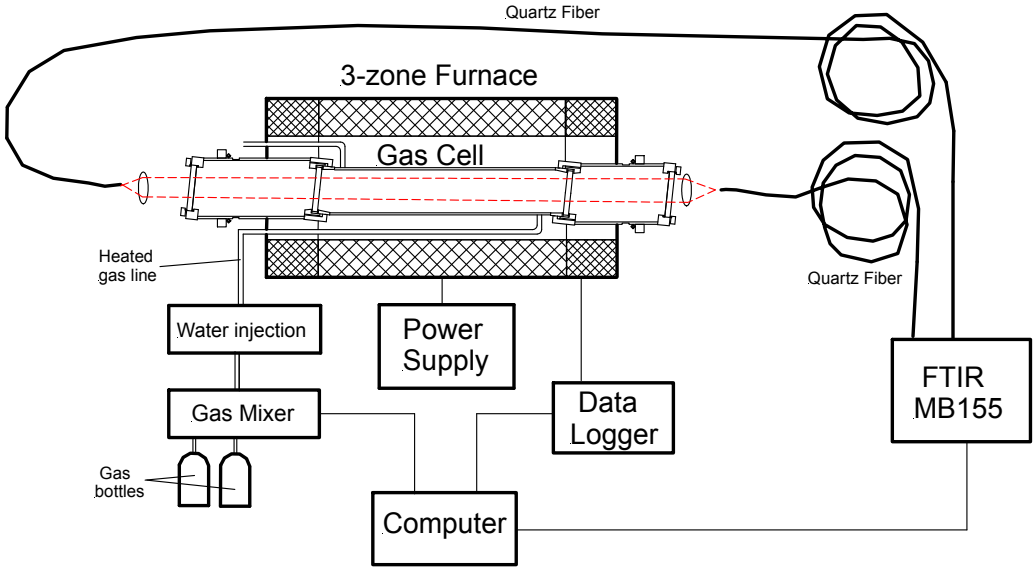




T_g, T_p, CO, CO_2, H_2O,...

Hot gas cell



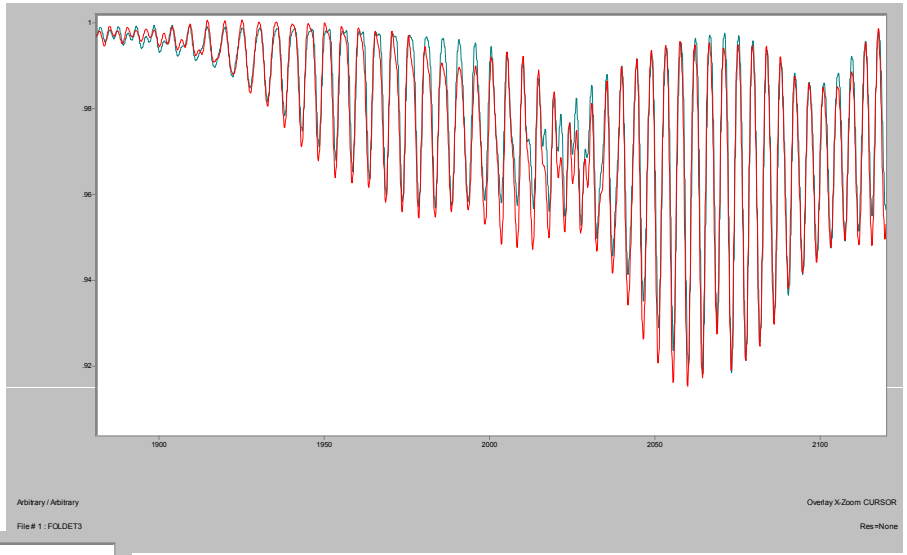


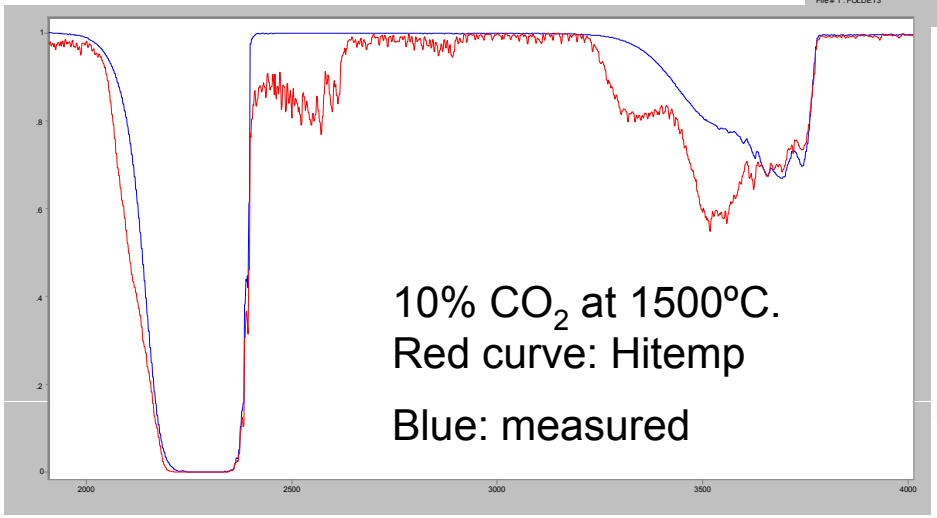
Temperature range: 23 °C - 1600°C
UV, VIS, IR, FAR,…

Gas reference data

Measured 1% CO spectrum

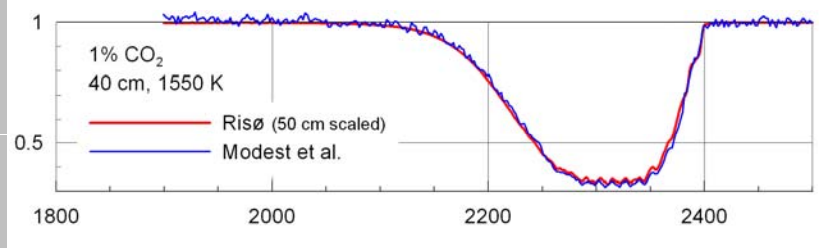
in hot gas cell at 1500ºC (red)





10% CO_2 at 1500ºC.
Red curve: Hitemp

Blue: measured

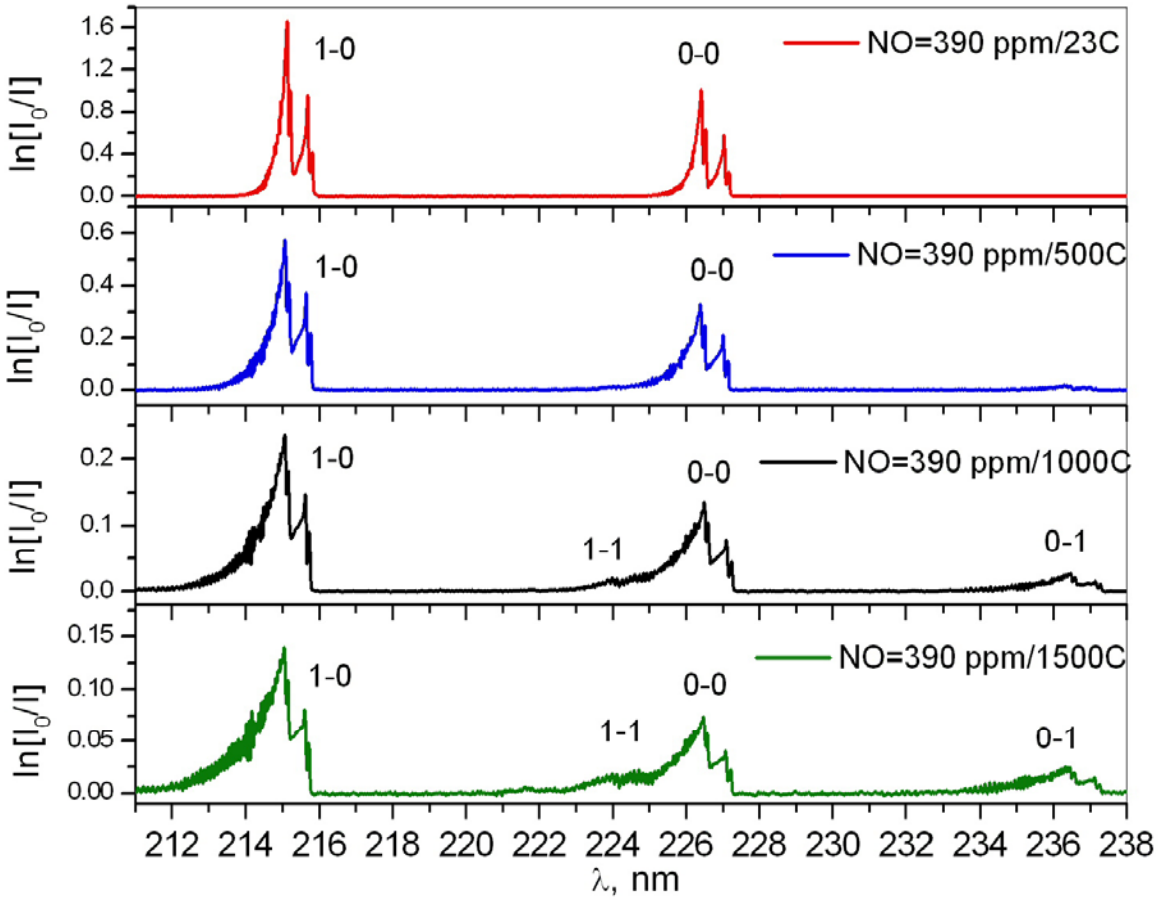


UV spectroscopy

Strong	Weak
Non-contact multi-gas analyzer for important combustion gases (O_2, NO, SO_2). Interference from H_2O and CO_2 is a minor problem. UV and IR method can be combined for non-contact, simultaneously and accurate measurement of gas temperature and gas composition (O2, NO, SO_2, CO, CO_2, H_2O, HCl, C_xH_y,…). Measuring time can in principle be few µs using pulsed UV source combined with fast and sensitive detector array (peltier cooled). Quartz fibre optics can be used in applications. High sensitivity NO and SO_2.	Short lifetime of UV source. Safety UV radiation (eye and skin). SO_2 limits applications. Reduced throughput for long fibre (>10 m). System stability requires great effort (vibration, ambient temperature, dust,…). Aging of system optical components due UV radiation could be a problem. Path length limitations for some applications. More sensitive to soot and particles in gas compared with IR techniques

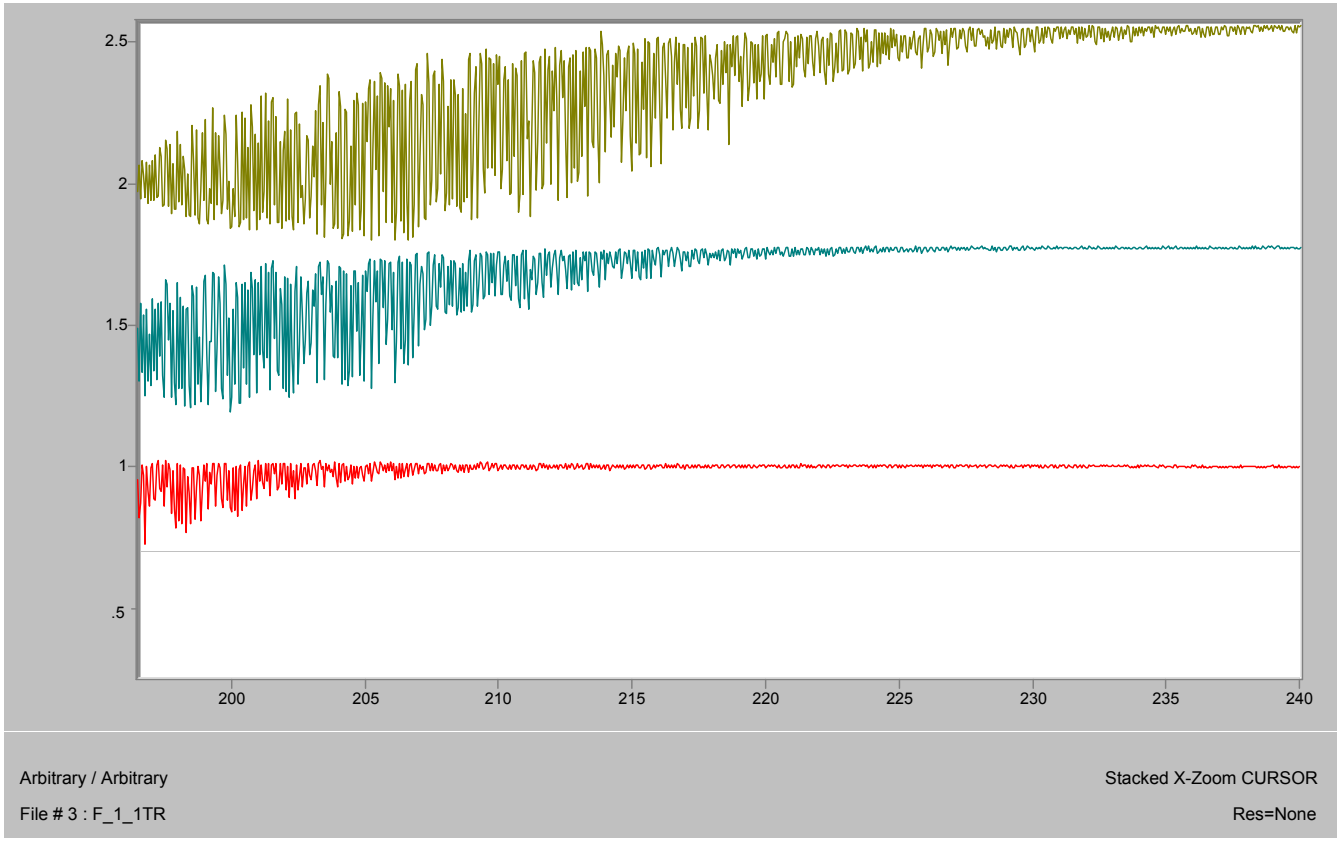
UV NO detection

λ=215 nm absorption band: $DT=DT_{rot}$ ±50°C



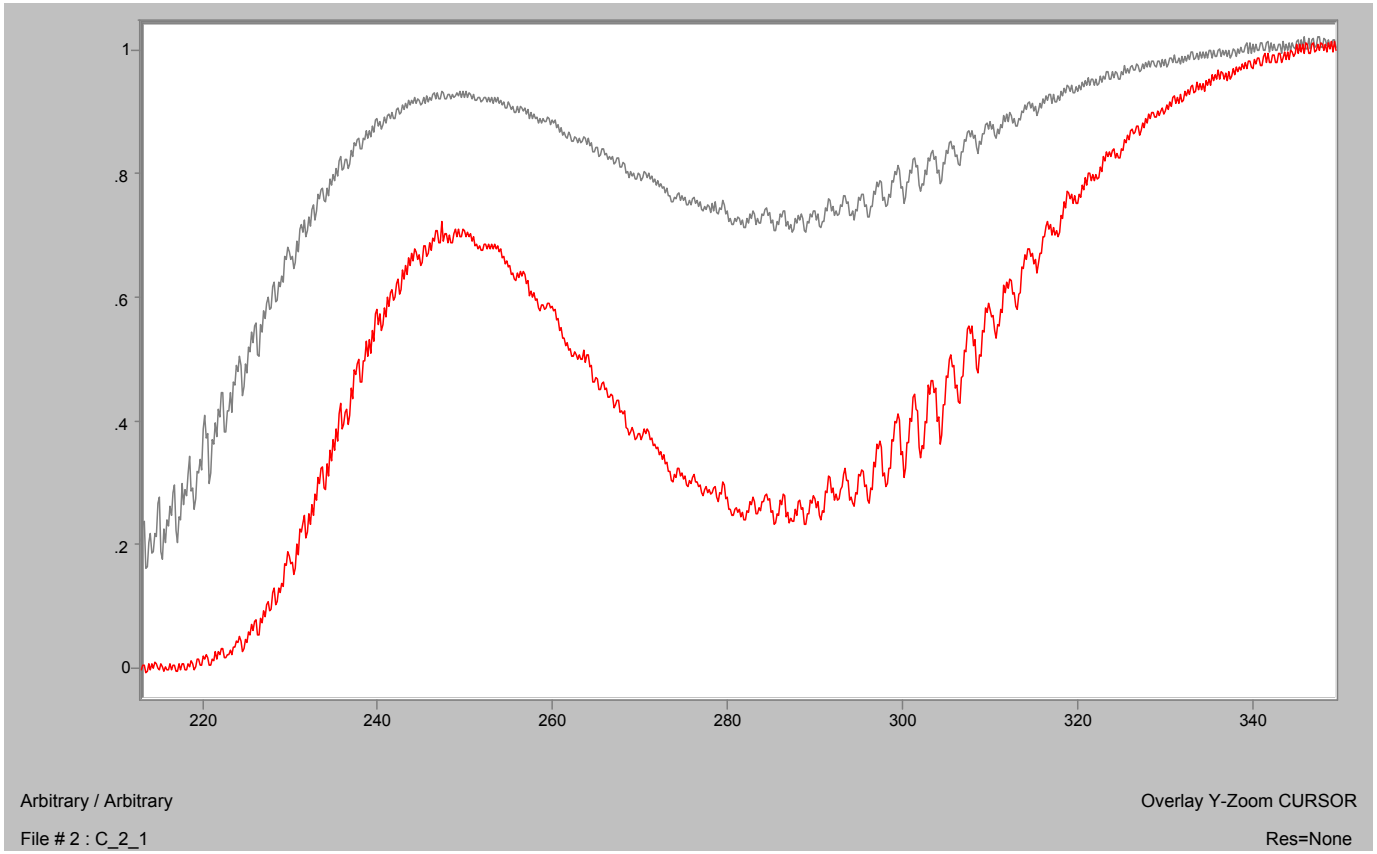
Paper: *In-situ Gas temperature measurements by UV-absorption spectroscopy*

UV O_2 detection



21% O_2 at 400ºC (red), 700ºC (cyan) and 1000ºC (green), 53.3 cm path length

UV SO_2 detection



Transmittance at 700ºC, 53.3 cm path length.
Grey curve 1154 ppm SO_2 in N_2 and red 5000 ppm in N_2

Kontakt/spørgsmål:

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